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Chaotic atrial rhythm has traditionally been a dysrhythmia of the seriously ill elderly patient and commonly associated with pulmonary disease. It has been reported less frequently in young individuals with and without pulmonary disease. An apparently healthy asymptomatic centrifuge subject was found to have reproducible epidoses of chaotic atrial rhythm only in the recovery period after exhaustive $+G_z$ simulated aerial combat maneuvering. The underlying mechanism responsible for initiation of chaotic atrial rhythm

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ABSTRACT (Continued)

is unknown, but may be related to distension of atrial tissue. In lung disease with attendant pulmonary hypertension or post $+G_z$ stress with the sudden increase in venous return, the necessary distension of the right atrium can be induced. The prognosis of individuals with chaotic atrial rhythm depends on the severity of the underlying illness, and is probably benign in apparently healthy asymptomatic individuals with normal cardiovascular evaluation.

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Clinical Medicine

Post-Acceleration Chaotic Atrial Rhythm

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WHINNERY, J. E. *Post-acceleration chaotic atrial rhythm.* Aviat.
Space Environ. Med. 53(4):390-392, 1982.

**Chaotic atrial rhythm has traditionally been a dysrhythmia of
the seriously ill elderly patient and commonly associated with
pulmonary disease. It has been reported less frequently in young
individuals with and without pulmonary disease. An apparently
healthy asymptomatic centrifuge subject had reproducible epi-
sodes of chaotic atrial rhythm only in the recovery period after
exhaustive +G$_z$ simulated aerial combat maneuvering. The un-
derlying mechanism responsible for initiation of chaotic atrial
rhythm is unknown, but may be related to distension of atrial
tissue. In lung disease with attendant pulmonary hypertension
or post +G$_z$ stress with the sudden increase in venous return, the
necessary distension of the right atrium can be induced. The
prognosis of individuals with chaotic atrial rhythm depends on
the severity of the underlying illness and is probably benign in
apparently healthy asymptomatic individuals with normal car-
diovascular evaluation.**

E LECTROCARDIOGRAPHIC FINDINGS of dis-
crete P-waves of at least three different morphol-
ogies, irregular P-P intervals, and an isoelectric baseline
between P-waves characterize the atrial dysrhythmia
known as chaotic atrial rhythm (1). If the atrial rate is
greater than 100 beats per minute (bpm) it has been
termed multifocal atrial tachycardia, although multifocal
atrial dysrhythmia, chaotic atrial tachycardia, and cha-
otic atrial mechanism have been used to describe this
phenomenon. The majority of the reports on this dys-
rhythmia have dealt with elderly, severely ill patients
and have been associated with an extremely high mor-
tality rate of 29-59% (3). Although less common, it has
been reported in younger patient populations and, rarely,
in apparently healthy individuals (2,7). In both elderly
and pediatric populations, significant acute and chronic
pulmonary disease is frequently associated with this
rhythm disturbance (2,8,9). The incidence of exercise
or other stress-induced chaotic atrial rhythm has not
been reported.

On the basis of the above clinical findings with as-
sociated high mortality rates the occurrence of this dys-
rhythmia in individuals with a critical occupation, such
as piloting single-seat aircraft, presents a difficult prob-
lem. This report documents the occurrence of repro-
ducible chaotic atrial rhythm in an apparently healthy
young individual during the immediate recovery period
only after high sustained +G$_z$ simulated aerial combat
maneuvering (SACM). The physiologic cardiovascular
changes that occur during the +G$_z$ recovery period are
discussed in light of previously documented pathophy-
siologic mechanisms suggested as etiologies for this dys-
rhythmia.

Case Report:

An asymptomatic, apparently healthy 29-year-old male, height 74
in (188 cm), weight 196 lb (88.9 kg), and a volunteer member of the
USAF School of Aerospace Medicine (USAFSAM) centrifuge accel-
eration panel was found to have reproducible episodes of chaotic atrial
rhythm during the immediate recovery period following exposure to
exhaustive 4.5-7.0 G$_z$ SACM profiles on the human centrifuge. This
+G$_z$ profile alternates 15-s plateaus of 4.5 and 7.0 G$_z$ (rate of onset
1 G/s) until exhaustion. The subject had passed a centrifuge-qualifying
USAF Class II flying physical examination which includes a normal
electrocardiogram, chest radiographs, and laboratory studies. Prior to
exposure to exhaustive high +G$_z$ SACM, a normal response to max-
imum treadmill exercise testing and normal spinal radiographic series
were obtained. He had a normal aeromedical G$_z$ tolerance (10). His
past medical history and family history were unremarkable, being
specifically negative for cardiac or pulmonary disturbances. His alcohol
intake was minimal, he rarely drank coffee, did not use tobacco, and
had no regular exercise program. After the first two episodes of the
post-G$_z$ chaotic atrial rhythm, a normal echocardiogram, two separate
non-dysrhythmic 24-h Holter monitoring studies, and normal pulmonary
function studies were obtained to ensure the absence of any abnor-
malities. The subject was not aware of any of the rhythm disturbances
and always remained asymptomatic.

Review of the subject's acceleration history revealed 18 separate
episodes on 18 different days, over a 5-month period, of post-G-stress
chaotic atrial rhythm. The mean length of the 18 dysrhythmic episodes
was 144 s (±48 s) with a maximum length of 195 s and minimum
length of 20 s. The mean length of time, post-G stress, from returning
to +1 G$_z$ until onset of the dysrhythmia was 18.6 s (±6) with a maximum
time to onset of 31 s and a minimum time of 10 s. The mean heart
rate at onset of the dysrhythmia was 159 bpm (±9), with a maximum

of 172 bpm and a minimum of 138 bpm. The mean heart rate upon return to a normal sinus rhythm was 93 bpm (± 7), with a maximum of 107 bpm and a minimum of 83 bpm. A representative tracing during one episode of chaotic atrial rhythm is shown in Fig. 1.

DISCUSSION

As previously described, chaotic atrial rhythm is probably due to a number of factors (8). Early reports overwhelmingly found a strong association of chaotic atrial rhythm with pulmonary disease. The characteristic patient could be described as seriously ill and elderly, suffering from acute or chronic pulmonary disease, very likely in association with cardiovascular disease (3,8). In this type patient, a very poor prognosis has been associated with the occurrence of this dysrhythmia. Mortality rates from 29-52% have been reported (3,4,6,8). Additional disturbances associated with chaotic atrial rhythm include electrolyte imbalance (hypokalemia), pulmonary embolism or infarction, valvular heart disease, congenital heart disease, diabetes mellitus, and hypoxia. It also occurs in apparently normal individuals. The duration of the chaotic atrial rhythm may be variable, from very short, one-time paroxysmal episodes to longstanding chronic episodes. The frequency of recurrence and the significance of paroxysmal episodes in normal individuals is unknown, as is the incidence of exercise-induced chaotic atrial rhythm, or its occurrence in the postexercise recovery period.

From our experience in centrifuge $+G_z$ experimentation and aeromedical evaluation, certain electrocardiographic disturbances are more frequently observed in the immediate post-stress recovery period. This includes marked sinus arrhythmia, A-V dissociation with a junctional rhythm, wandering atrial pacemaker (only two discrete P-wave morphologies with the rate less than 100 bpm), and sinus bradycardia. An occasional prolonged sino-atrial block has also been seen in the post-G_z stress recovery period (11). Their occurrence during this period has been thought to be related to increased vagal tone associated with a large venous return which occurs when the $+G_z$ stress is decreased. This increased venous return certainly results in transient right heart distension. The common stress present in pulmonary disease and post $+G_z$ stress may be right atrial distension, with the chaotic atrial rhythm resulting from stretching of the atrial fibers (1,2,8). The effects of atrial dilation on the cellular electrophysiology of atrial fibers from patients with dilated atria revealed the properties necessary for reentrant arrhythmias. The properties of the tissue from dilated atria included reduced (less

negative) resting membrane potentials and predominant slow-response action potentials (5).

Certainly hypoxemia, respiratory alterations, electrolyte disturbances and autonomic imbalance occur during and in the immediate post-recovery phase following high sustained $+G_z$ stress and may be contributing factors. Lesions of the sinus node, such as from injury or ischemia, with impaired blood supply to the sinus node have also been shown to be responsible for a variety of atrial dysrhythmias (1,8). Any unique $+G_z$-induced compromise in flow to the sinus node could induce dysrhythmias; however, this would seem more likely to occur during G stress rather than being restricted to the post-G recovery period.

This report lends no evidence to indicate that chaotic atrial rhythm is an autonomous dysrhythmia but rather that it is more likely to be merely an accentuation of the other more frequent dysrhythmias seen in the immediate acceleration recovery period, such as a wandering atrial pacemaker. The occurrence of chaotic atrial rhythm in young individuals with otherwise normal cardiovascular systems is assumed to be benign, with treatment not indicated as long as they remain without symptoms. Whether or not these individuals are at increased risk for sudden incapacitation remains unknown, and caution must be advised because of the previously described high mortality rates seen in patient populations. Previous work has suggested that chaotic atrial rhythm may frequently progress to atrial fibrillation (5). At present, all forms of atrial tachycardia, flutter, and fibrillation are disqualifying for USAF flying duties. We have not seen any episodes of these disqualifying atrial dysrhythmias associated with $+G_z$ stress, nor did the subject in this case report progress to atrial flutter or fibrillation.

The time delay (mean 18.6 s) from return to $+1$ G_z until the onset of the chaotic atrial tachycardia is not unique to this dysrhythmia. The other previously mentioned post-G_z-stress rhythm disturbances also have a similar characteristic delay. The exact kinetic relationship of the humoral, hemodynamic, and metabolic changes in the late G_z stress and post-G_z recovery period would be very important and could give much insight into the etiology of such cardiac rate and rhythm disturbances. This time delay may be a reflection of the time necessary for the cellular electrophysiology to be altered by the resultant atrial distension caused by the increased venous return. The episodes of chaotic atrial rhythm lasted as long as the heart rate in recovery remained above 100 bpm, with its onset near 160 bpm.
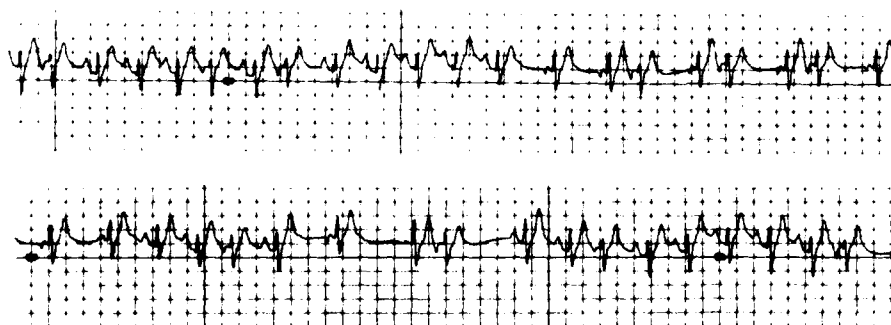

Fig. 1. Sternal electrocardiographic lead showing chaotic atrial rhythm in the post-SACM immediate recovery period (continuous tracing).

The questions relating to possible rate dependence and the factors affecting the length of the episodes (mean length 144 s) are unknown.

The high $+G_z$ environment of the advanced fighter aircraft pilot is stressful, with a multitude of cardiovascular disturbances that may arise. Certain apparently healthy asymptomatic individuals exposed to high $+G_z$ SACM may manifest cardiac dysrhythmias during and after the stress. Although many of these dysrhythmias are considered ominous when they occur in patient populations, they are probably benign in asymptomatic individuals with normal complete cardiovascular examinations. The chaotic atrial rhythm in this case resulted from the physiologic alterations associated with $+G_z$ stress and was evidently not related to any pathologic process. The prognosis of individuals with dysrhythmias such as chaotic atrial rhythm probably depends on the severity of the underlying illness.

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